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REVIEW ARTICLE

Nutritional values, Nutraceutical properties, and health benefits of Arabian Date Palme fruit

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ABSTRACT

The date palm is widely known as a richer nutritional source and natural medical agent. Date fruit is a major source of carbohydrates and dietary fiber, and it has contains proteins, minerals, vitamins, phenolic compounds, carotenoids, sterols, and triterpenoids. The beneficial potential of this fruit is well known in Arab countries and even in the world. Date fruit has many health benefits such as Glucose-lowering potential, anti-cancer activity, antioxidant activity, hypocholesterolemia-lowering potential, antimicrobial activity, anti-inflammatory activity, bone stimulating activity, which is attributed to the existence of bioactive substances such as carotenoids, polyphenols, triterpenoids, flavonoids, sterols, and some vitamins and minerals. Overall, Arabian date palms' nutritional values and pharmacological activities remain to be explained. Thus, this study states the history, nutritional and health effects of Arabian date palm, highlighting the possibility of palm date components developing novel beneficial approaches for managing the abovementioned illnesses.

Keywords: Arabian date palm; Arab's tree; Nutritional values; Pharmacological activities

INTRODUCTION

The trees of Date Palm are among the oldest trees worldwide, and their fruits were cultivated and consumed for centuries as food by the Arabian people, it acts a main function in their social life and economy (Chao and Krueger 2007, El-Deek et al., 2010, Yahia 2011, Yahia et al., 2014). Date palm plants (*Phoenix dactylifera* L., Arecaceae) are among the ancient plants that were planted on Earth. It commonly grows in the warm and arid climate rejoins, such as Arabian Peninsula, Middle East, Asia, and Africa. It considers an important nutrition resource for the people of these regions, and it also has an essential function in their diet and their daily life (Al-Farsi et al., 2005, Shafiei et al., 2010).

Dates are the most important way of nutrition and sustenance for the desert and semi-arid regions due to the excellent adaptation of palm trees to the harsh climatic environments of these areas. More than three thousand varieties of dates have been found globally (Kabir 2014). The most diverse genetic origin of dates is found in Tunisia, Sudan, Iran, Oman, Qatar, Iraq, Iran, and recently in the UAE (Zehdi et al., 2004, Elshibli and Korpelainen, 2008, Ahmed and Al-Qaradawi, 2009; Elmeer et al., 2011, Khierallah et al., 2011, Arabnezhad et al., 2012, Zehdi et al., 2012, Chaluvadi et al., 2014, Racchi et al., 2014). Palm trees are mainly grown for human Nutrition, except for some traditionally grown varieties for animal feed. Palm trees and their fruits are known for their food, household, and industrial application. Historically, nearly every part of the palm tree has been used for housing and kitchen utensils, art, agriculture, etc. Overall, the annual global production was about 9.1 million tons in 2019 (Rome 2020). Despite establishing new agricultural methods for date production in Asia, America, Australia, and Africa, the Middle East and North Africa are still at the forefront.

The process of harvesting and marketing the fruits of dates takes place according to the three major phases of date ripening, (i) the Kamri stage, (ii) the Khalal stage (before ripening), and (iii) the Rutab stage (soft and ripe) or the dates (mature) (Yahia 2011, Yahia et al., 2014). Though some date varieties take a long period in the stage of the pre-ripening due to the existence of tannins, as the dates ripen, the presence of tannins begins to decrease, and upon reaching the mature stage, the tannins disappear completely.

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Moreover, palm fruits are considered as a "whole food" and "healthy diet" as it contains appropriate quantities of fibers, lipids, carbohydrates, vitamins, essential minerals, and antioxidants (Al-Shahib and Marshall, 2002, Al-Farsi et al., 2005, Biglari et al., 2008, Siddiq et al., 2013, Al-Harrasi et al., 2014, Eoin 2016, Al-Alawi et al., 2017, Hussain et al., 2020, Idowu et al., 2020). Dates are also rich in antioxidants such as polyphenols, carotenoids, flavonoids, sterols, and procyanidins (Biglari et al., 2008, Gheisari et al., 2020, AlFaris et al., 2021). That has potent health benefits., which have favorable health effects on several chronic illnesses like hyperlipidemia, diabetes mellitus, liver diseases, and autoimmune syndrome (Barros, 2020, Echegaray et al., 2020). Date fruits have been used in traditional medicinal uses in the treatment of many diseases for many years (thousands), in addition to their main function in feeding the population of the Arab countries (the MENA region).

Despite several publications on date palm in general, some aspects of Arabian date palm fruit still need further exploration, particularly nutritional, functional, and healthy aspects of dates and industrial applications. Therefore, in the current investigation, we explored the dietary values, nutraceutical, and therapeutical properties, other health benefits of Arabian dates, and recent studies.

NUTRITIONAL VALUE AND QUALITY OF DATES

Macronutrients

For decades, several date varieties cultured in the diverse regions have been carried out on the nutritional values of numerous pieces of research (H. 1993, Al-Shahib and Marshall 2002, Al-Farsi et al., 2007). The nutritional composition of Palm Date fruits is summarized in Table 1.

On average, the water amount of the fresh and dry date's fruit is form 42.4% and 15.2%, respectively. The moisture content of dates fruit is varies according ripening stages it diminutions with progression in ripening stages. The lowest moisture contents are in the ripened date (Tamar), it also varied among the varieties, it was found to have altered between 39.04% and 11.34 for *Ourous* and *Oukasaba cultivar*s, respectively (Al-Farsi et al., 2005, Al-Farsi* and Lee 2008, Ahmed et al., 2022). In the ripening stages, water percentage ranges varied between 7% and ≥79% in the dry and moist varieties respectively (Chandrasekaran and Bahkali 2013).

Date fruit is branded by its increased carbohydrates content that forms the major constituents. The majority of carbohydrates in date fruit mainly reduce sugars (glucose, mannose, maltose, and fructose), the nonreducing carbohydrates like sucrose, in addition to minor polysaccharides quantities (Al-Shahib and Marshall 2002, Kacem-Chaouche et al., 2013). The levels of reducing sugars and sucrose are invertase activity depending on the rate of invertase (Fayadh and Al-Showiman 1990). For date cultivars in Algeria, the total saccharides amount differs between 84.51 and 96.28 % of dry matter (Ahmed et al., 2022), also it reported that the dried dates contains about 64.1g/100g of carbohydrates, the contents of sucrose, fructose and, glucose were 11.6, 29.4, and 30.4g/100g respectively (Yousif et al., 1982). Assirey study revealed that among 10 varieties of date, Bumi was shown to have the highest carbohydrates followed by Suqaey and Khodari 81.4%, 79.7%, and 79.4%, respectively. In contrast, the smallest carbohydrates, 71.2% were found in Labanah (Assirey 2015). Also, date fruits are considered as an energy source due to their high level of sugar (44-88%), as well as it contains 2.3-5.6% of protein, 6.4-11.5% of dietary fiber, various vitamins and minerals (Al-Shahib and Marshall 2003).

Previous distinct research signposted the highest total protein content in Qushjabrin (3.78% of dry weight), Qush Balquan (3.64 g/100 g DW), Helali Oman (3.55 g/100 g DW), and Handal (3.18 g/100 g dry weight), Fardh had the lowermost (2.63 g/100 g dry weight) (Al-Harrasi et al., 2014). Also, the study of Borchani et al. (2010) compared the crude protein contents and displayed the highest proteins in the variety Lulu, followed by Deglet Noor and Hallawi, whereas Khasab had the lowermost protein content. In another study, crude protein content was highest in Shlaby (4.73% of dry weight), then Labnah (3.87 % of DW), Anabarah (3.49 % of DW), and Khodari (3.42 % of DW), while Mabroom possessed the little crude protein (1.72 % of dry weight) (Assirey 2015).

Dietary fiber is made from edible plant resources such as polysaccharides in the wall of cells that are indigestible in the digestive system of humans. Dietary fibers function in human health by treating various diseases, such as colon cancer, since they can trap external and internal mutations. For instance, the crude dietary fiber in "Ajwa" and "Deglet Nour" were 18.4% and 12.4% of dry matter, respectively, the percentage of insoluble fibers in date varieties was 9.19% and 11.7%, whereas the amount of soluble dietary fibers were 5.16% and 6.68% respectively (Elleuch et al., 2008).

Moreover, dates fruit is described as a respectable source of essential amino acids AA, comprising histidine and arginine, considered fundamental for the human body's physiological functions (AL-ASWAD 1971, Al-Farsi et al., 2007, Idowu et al., 2020). An investigation exposed that the fresh dates amino acids AA were described to comprise glycine as the utmost copious amino acid 65 μmoL/g FW, followed by proline, alanine, and lysine (16, 9.2, and 7.3 μmoL/g FW), respectively, however the lowest amino acid (0.001 μmoL/g FW) was cysteine (Hamad et al., 2015). Also, Assirey. (2015)

Table 1: Nutritional composition of Date fruits

Components	Quantities	References
Energy	2762 kcal/kg	(Schulte 2018)
Moisture	Kimri 83.6% and Tamar 24.2%, 11%	(Al-Shahib and Marshall, 2002, El-Sharnouby et al., 2014)
Protein	2.3–5.6%, 2.5 – 6.5% 2.63-3.78% 1.6-2.4% 1.72-4.73% 2%	(Pennington 1989) (Ahmed et al., 1995) (Chaira et al., 2009) (Al-Harrasi et al., 2014) (Borchani et al., 2010) (Assirey 2015) (El-Sharnouby et al., 2014)
Carbohydrates	3.4% -7.7% in Kimri, 43.40% -87.54% in Tamar. Deglet Nour (74.11%) Madjool (66.40%) Khanizi (87.54%), Allig (53.22%) In Algeria 84.51-96.28 g/100g Dm for Deglet nour cv (56.6%) Burni 81.4%, Suqaey79.7%, Khodari 79.4%. Riziz Date 79% Glucose 35.4-52/3% Fructose 28.1-52.5% Sucrose 2.9-13.3% Maltose 22.5% Galactose 12.2%	(Al-Shahib and Marshall 2003) (Guizani et al., 2010) (Rock et al., 2009) (Sahari et al., 2007) (Elleuch et al., 2008) (Ahmed et al., 2022) (Kchaou et al., 2013) (El-Sharnouby et al., 2014) (Assirey 2015) (Assirey 2015, Hamad et al., 2015, Khalid et al., 2016)
Ash	1.7%, 3%	(Al-Shahib and Marshall, 2003, El-Sharnouby et al., 2014)
Lipids	0.1% to 3.25%, 2%	(Al-Farsi et al., 2007, Sahari et al., 2007, Guizani et al., 2010, El-Sharnouby et al., 2014)
Fiber	8.6%, 10.9-13.5%, Pectin 3%, in Tunisian 4.7–7 g% DF	(Myhara et al., 1999, Al-Shahib and Marshall, 2003, Elleuch et al., 2008, El-Sharnouby et al., 2014, Mrabet et al., 2017).

found that glycine, alanine, asparagine, proline, glutamate, and arginine were (77–96, 72–99, 127–225, 86–113, 158–265, and 37–93 (mg/100g)) respectively, which present as the main essential amino acids)AA(whereas the lowest amino acid content (13–46 mg/100g) was tryptophan. The date's color also influences the quality of the dates during the growth stages; their green color in the Kamri stage changes to red or yellow in the Khalal stage, depending upon the variety of dates. However, in the ripping stage, the dates finally become brown in color. The intensity of the color in the ripping phase depends on the variety and dehydrating methods (Vayalil 2012).

Micronutrients

In addition to the essential nutritional compounds, the fruit of the date is considered an excellent source of vitamins, minerals, and beneficial phytochemicals, including polyphenols, carotenoids, and sterols (Guizani et al., 2010, Baliga et al., 2011, Vayalil 2012). A work exhibited that consuming 100g of the Arabian date palm meets nearly half of the dietary recommended intake (DRI) of micronutrients. Therefore, increasing areas for growing dates are recommended due to their nutritional importance in reducing micronutrient deficiencies in the human body (Shabani et al., 2016).

Vitamins

Dates possess a family of B complex vitamins, including folic acid (B9), nicotinamide (B3), thiamine (B1), pyridoxine (B6), riboflavin (B2), cyanocobalamin (B12), and pantothenic acid (B5) (Chandrasekaran and Bahkali 2013).In particular, Dates contain good concentrations of at least six types of vitamins, including vitamin A, riboflavin, thiamine, ascorbic acid, niacin, and pyridoxine (Al-Hooti et al., 1997, Al-Shahib and Marshall 2003, Al-Farsi* and Lee 2008).

Also, certain vitamins (B3, B9, B5, B6) were present in higher levels in date fruit. The niacin level ranges between 1.27 and 1.61 mg/100 g. However, there is a great difference between different varieties in the water-soluble vitamin concentrations during the ripening stages of dates (Aslam et al., 2013). Furthermore, Vitamins B5, B6, B3, and B1 are presented in the highest concentration in the ripening stages, and the presence of B9, B12, and B2 vitamins was discovered in immature dates. In general, vitamin concentration in the dry dates is lesser compared with that of fresh fruit dates due to losing vitamins during drying. In summary, the fruits of date are considered a respectable vitamin source compared with the other dried fruits (USDA., 2016).

Minerals

Gorgeous Phytochemical composition of Date's fruit in mineral contents, especially calcium, potassium, copper, selenium, iron, magnesium, zinc, and manganese (Al-Shahib and Marshall, 2002, Baliga et al., 2011, Vayalil 2012). These slight micronutrients are bio-vital for natural

functional roles in the human body; for instance, Zn is an essential element for the suitable operation of the immune system, Sodium Na is necessary for the breathing process, and the Iron Fe is for battling physical weakness (Vayalil 2012). In particular, they contain high potassium levels and minimal sodium quantities. The iron quantities in some varieties were 4-60% recommended dietary allowance (Al-Shahib and Marshall, 2002, Al-Farsi et al., 2005, Al-Farsi et al., 2007). Furthermore, dates fruit contains a high concentration of Zinc, especially the Medjool variety. Its content increases from about 2 to 11 times compared with other types. Besides, this fruit contains a high content of selenium compared to other fruits, since the selenium content ranged from 0.24 mg/100g in some varieties such as "Al-Barhi" and 0.4 mg/100g in the "Fard" and "Khasab" varieties. Thus, dates are considered an essential source of selenium since the recommended dietary allowance (RDA) level of selenium/person is 0.55 mg. What is more, it contains high iodine levels(Duke 2015). However, the differences in the level of minerals depend on the date varieties, geographical locations, environmental conditions, and ripeness of dates (Ahmed et al., 1995; Al-Hooti et al., 1997; Mohamed, 2000, Al-Farsi et al., 2005; Ismail et al., 2006; Al-Farsi et al., 2007; Sahari et al., 2007).

PHYTOCHEMICAL COMPOSITION OF DATES

Date fruits are rich in secondary metabolites substances like carotenoids, polyphenolic compounds, flavonoids, tannins, tocopherols, tocotrienols, sterols, triterpenoids, and other antioxidant compounds. The phytochemical composition of date fruits is extracted from several studies and illustrated in Table 2.

Carotenoids

Carotenoids are hydrocarbon components consisting of 40 carbon (tetra-carbonate) atoms. The color of these components varies according to their structure, categorized by the intense double-bond system. The main carotenoids of various dates include lutein, β-carotene, lutein, zeaxanthin, neoxanthin, lycopene, leucoxanthin, and flavoxanthin (Boudries et al., 2007, Manickavasagan et al., 2012). Furthermore, other substances of carotenoids, including b-ziacarotene, cis-violaxanthin, and α-carotene were recognized too in the fruit of dates (Ben-Amotz and Fishier, 1998). In date varieties, the total carotenoid levels were between 0.22 and 3.0 mg/100g, contingent on maturity stage as well as varieties (Gross et al., 1983; Al-Farsi et al., 2005; Al-Farsi et al., 2007; Boudries et al., 2007). In some Omani varieties, such as Al-Khalas, Al-Fard, and Al-Khasab, the total carotenoids are 3.03,1.39 and 1.31mg/100g, respectively (Al-Farsi et al., 2005; Al-Farsi et al., 2007). The whole carotenoids concentration in Medjool and Deglet Noor dates were 81 μg/100g (lutein and zeaxanthin 75.0 μg and 6 β -carotene.0 μg), 112 μg/100g (89.0 μg of lutein and β -carotene combined with zeaxanthin), respectively (USDA, 2016). The values of carotenoid and pro-vitamin A in three Algerian dates varieties, namely "Tanbiya" "Deglet Nour", and "Hamraya" in the three diverse maturity stages, displayed that lutein was the main existing carotenoid and β-carotene was the next (Boudries et al., 2007).

The β-carotene content was 2.5, 6.4, and 3.3 mg/100g in "Tantebouchte" "Deglet Noor", and "Hamraya" respectively, whereas the Lutein content in mentioned varieties was 33.6, 156, and 28 mg/100g, respectively (Boudries et al., 2007; Al-Farsi and Lee, 2008). The activity of provitamin A in dates decreases during the pre-stage to the date stage, and its content ranges between 0.4-12 μg of RAE/100 g (Boudries et al., 2007). Several factors affect the number of carotenoids, such as the variety of dates, maturity stage, and the environments of post-harvest. Gross et al. (1983) displayed that the carotenoid content decreases rapidly as the date ripens. In addition, Maqsood et al. (2020) and Makki et al. (1998) stated that about 4-30% of the carotenoid content of dates disappeared by exposure to direct sun drying. Additionally, it was found that freeze-dried dates contain a much lower carotenoids percentage, which is approximately 0.18 mg % of the fresh weight (Maier et al., 1964). The changes in the carotenoids lead to the deterioration of dates, such as autoxidation. Furthermore, the carotene content in fruits decreases dramatically during the ripening and transfer stages. This may be due to moisture loss during the ripening stages (Gross et al., 1983).

Polyphenols

The evidence supports polyphenols' contribution to preventing cardiovascular disease, osteoporosis, and cancers, in addition to their role in preventing neurodegenerative diseases and diabetes (Shahidi and Ambigaipalan 2015). The main classes of polyphenols are phenolic acids, flavonoids, lignans, and tannins. Polyphenolic components, both flavonoids and non-flavonoids, augment the antioxidant capabilities of dates (Maqsood et al., 2020). In date fruit, the Polyphenolic acids are the primary tannins components and are liable for the date fruit's dark color [(Makki et al., 1998). Dactylphenic acid was isolated firstly, and it was clarified by its structure as 3-O-caffeoyl shikimic acid (Maier and Metzler 1965; El Hadrami and Al-Khayri, 2012). The recognized phenolic composites in the fruits of the date are quercetin, luteolin, apigenin, the derivatives of malonyl, kaempferol, isorhamnetin, chrysoberyl, and 3-methyl-isorhamnetin (Hadrami et al., 2011). Besides, gallic acid, proteolytic acids, fluoxyhydroxybenzoic acid, sernic acid, vanilla, and caffeic acid are the primary phenolic

Table 2: The phytochemical composition of the palm date fruit

Groups	Quantities	Compounds	References
Carotenoids	0.22 to 3.0 mg/100g, 3.03,1.39, and 1.31mg/100g	Lutein, β-carotene, lutein, zeaxanthin, neoxanthin, lycopene, leucoxanthin, and flavoxanthin, cis-violaxanthin, b-ziacarotene, and α-caroten, and provitamin A.	(Ben-Amotz and Fishier, 1998; Al-Farsi et al., 2005; Boudries et al., 2007; Al-Farsi and Lee, 2008, Manickavasagan et al., 2012).
Phenolic compounds	193.7-239.5 mg/100 g, for dried and fresh fruits, anthocyanins 0.24-1.52 mg of cyanidin-3-glucoside equivalents/100g. TP 169.18-381.76 mg of GAE/100 g dm, in Algerian date	Gallic acid, protocytic acids, fluoxyhydroxybenzoic acid, sernic acid, vanilla, caffeic acid coumaroylquinic acid, sinapic acid, xanthoxylin, hydrocaffeic acid, and 5-O-caffeoylshikimic acids, ferulic acid, pro-tocatec acid, serenic acid, vanillic acid, also the bound phenolic acids such as prototoxic acid, hydroxybenzoic acid, syringic acid, folic acid, p- and o-coumaric acids, proanthocyanide. p-Coumaric acid, protocatechuic acid, tyrosol, coumarin, hydrocaffeic acid, caffeoylshikimic acid, pcoumaric acid, cerulic acid and Akerbouche, cinnamic acid and sinapic acid. chlorogenic acid, protocatechuic acid, isovanillic acid, chlorogenic acid, isoferulic acid, and hydroxycinnamic acid.	(Regnault-Roger et al., 1987; Lorente and Ferreres 1988; Gu et al., 2003; Al-Farsi et al., 2005; Mansouri et al., 2005; Hong et al., 2006; Al-Abid, 2012; Eid et al., 2013; Daoud et al., 2019).
Flavonoids	1224–1844 mg Rutin equivalent/100 g DW, catechin (3.38 g/kg) and epicatechin (46.8 g/kg). TF 28.68 and 95.22 mg quercetin E/100 g dm.	flavonoid glycosides, pranthocyanides, procyanidins, quercetin, apigenin, catechins, epicatechin, Proanthocyanidins, and hydroxamic acid derivatives such as ferulic acid, sinapic acids, p-coumaric acid, luteolin, isoquercetrin, and rutin	(Gu et al., 2003; Mansouri et al., 2005, Vinson et al., 2005, Hong et al., 2006, Allaith 2008, Biglari et al., 2008, Al-Abid 2012, Eid et al., 2013, Habib et al., 2014, Hamad et al., 2015, Alem et al., 2017, Al Juhaimi et al., 2018).
Phytosterols and triterpenoids		Pinoresinol, daidzein, coumesterol, formononetin, glycitein stigmasterol, genistein, matairesinol, secoisolariciresinol, lariciresinol, esterone, ergosterol, estrogen and campesterol, brassicasterol, , isofucosterol, and β-sitosterol and five-triterpenoid lupeol (lup-20 (29) en-3P-0l) stigmasta-5,22-diane-3-a, β-sitosterol, lupeol 24-methylene clenchlortanol, 24-(Erubidenin-3-a), sigmastan-5-5-diene, and cholesterol-4-n - 3-, 4-methylcholest-4-en-3-one, stigmast-4-en-3-1, spinasterone and cholesta-3,5-diene.	(Kikuchi and Miki, 1978; Duke 2001; Thompson et al., 2006; Liolios et al., 2009; Al-Abid 2012; Maqsood et al., 2020).
Tocopherols and tocotrienols	24.97–38.85%	ά-tocopherol acetate, ά- reported, ά-tocotrienols, γ-tocotrienol γ-tocopherol	(Besbes et al., 2004; Nehdi et al., 2010; Habib et al., 2013; Al Juhaimi et al., 2018; Nehdi et al., 2018; Mrabet et al., 2020).
Antioxidants	The total antioxidants ranged from 8,212 to 12,543 μl of Trolox equivalent/g,	Selenium at a rate of 0.356 to 0.528 mg/100g Carotenoids 0.92 to 2.91 mg/100g and phenolics content with a mean of 217 to 343 mg of ferulic acid equivalents/100g. Proanthocyanidin, flavonoids, cyanidin, β-carotene, β-sitosterol, and selenium all have anti-ulcer properties	(Al-Qarawi et al., 2004; Al-Qarawi et al., 2005; de Lira Mota et al., 2009; Eid et al., 2013; Al-Jasass et al., 2015).
Volatile odors	80 – 100 volatile components	1 lactone, 6 ketones, 10 terpenes, 12 hydrocarbons, 13 aldehydes, 20 esters, and 19 alcohol, phenylethyl alcohol ,2-propanol, isoamyl acetate, and isoamyl alcohol, ethyl acetate, isopropyl acetate, acetaldehyde, octanal alcohol, furfuryl, 5-methylfurfural, 6-valerolactone, linalool, 6-valerolac, and unicalactone	(Torres et al., 1996).

acids of dates (Regnault-Roger et al., 1987). Furthermore, other acids were identified in various Algerian ripe dates, like coumaroylquinic acid, sinapic acid, xanthoxylin, hydrocaffeic acid and 5-O-caffeoylshikimic acids (Mansouri et al., 2005). The existence of the free acids such as ferulic acid, pro-tocatec acid, vanillic acid, serenic acid, in addition to the bound phenolic acids such as proteotoxic, gallic, hydroxybenzoic, caffeic, vanillic, syringic, folic, ferulic, p-coumaric, and o-coumaric acids were stated in the three Omani dates varieties (Al-Farsi et al., 2005). Particularly, Flavonoids of dates consist mainly of flavonoid glycosides, pranthocyanides, and procyanidins(Lorente and Ferreres, 1988; Gu et al., 2003; Mansouri et al., 2005; Hong et al., 2006). The presence of proanthocyanide has been stated in "Zahidi" dates (Al-Abid 2012).

It was found that the date fruit has the uppermost content of polyphenols in the dried ripe date fruits and the polyphenol number of fresh dates is higher 6 times than of dried dates (Vinson et al., 2005). The total polyphenols in

date variations were evaluated at diverse stages of maturity and in the treated date varieties (Al-Farsi et al., 2005, Al-Farsi et al., 2005, Vinson et al., 2005, Allaith 2008). In certain variations, the total phenolic level ranged between 193.7 and 239.5mg/100 g in both dry and fresh fruits, respectively (Al-Farsi et al., 2005; Al-Farsi et al., 2005). Moreover, it was stated that the drying process increases phenolic acids by 64% to 107% and polyphenols by 22% to 153%. In connection with this, Phenolic acids are mainly present as coumaric acid, cinnamic acid, and all derivatives (Manickavasagan et al., 2012). It was found that phenolic quantity increases after drying, probably because of the degradation of tannins and the decreased enzyme activity during the drying process (Mohamed. 2000). Accordingly, the total phenol contents of some selected varieties of Iraqi date palm were found to be 475.5- 315.6 mg GAE/100 g. For date anthocyanins, the content of the anthocyanins in fresh dates fruit showed to be 0.24-1.52 mg of cyanidin-3-glucoside equivalents/100g based on the variety (Al-Farsi et al., 2005; Al-Farsi and Lee 2008). In the date stage, most of the anthocyanin content and the Flavan-3-ol units crystallize into proanthocyanidins, forming insoluble tannin acid (Al-Abid 2012). The presence of acetone, acetic acid, and water in the dates indicates that procyanidins were present in higher molecular weight polymers (Hong et al., 2006).

Flavonoids

Al Juhaimi et al. (2018) Stated that the flavonoid components like rutin and catechin were found in 30 Saudi date palm fruit varieties. For date flavonoids, date fruit contains high quantities of flavonoids, which are composed of quercetin, apigenin, catechins, epicatechin, Proanthocyanidins, and hydroxamic acid derivatives like ferulic acid, sinapic acids, as well as p-coumaric acid (Hong et al., 2006; Biglari et al., 2008; Al Juhaimi et al., 2018; Daoud et al., 2019). Additional research showed that 13 Saudi Arabian date varieties were found to contain flavonoids like rutin and catechin (Al Juhaimi et al., 2018). In particular, the fruit of Dates is rich in flavonoids and phenolic acids (Daoud et al., 2019). In an investigation of 3 date varieties from Morocco, including (Boufgous, Majhoul, and Bousthammi), it was found to have about 1224–1844 mg Rutin equivalent/100g.DW of flavonoid substances (Habib et al., 2014). Also, Habib et al. (2014) found that Monomeric and Polymeric flavan-3-ols types were discovered that established about 99% of isolated total polyphenols like catechin (3.38 g/kg) and epicatechin (46.8 g/kg) throughout the determination of the flavonoid in dates quantity.

Phytosterols and triterpenoids

Phytostanols refer to plant steroids, and their hydrogenated counterparts are phytosterols that only exist in the plants. Structurally, it is linked to cholesterol nonetheless, it possesses a different side-chain structure. It consists of a decimal structure of a steroid with an aliphatic side chain linked with a C-17 atom of the D ring. C-5, a hydroxyl group devoted to the C-3 atom of the ring A and C-6, which is equivalent to a portion of sterols, while this bond is saturated with phytostanols. In Allig and Deglet Noor varieties, the sterol amount in the seed of date were 3000 and 3500 mg/kg, respectively (Besbes et al., 2004). The Triterpenoids are precursors of Rh steroids that possess a functional C30 skeleton. The Pentacyclic triterpenes are a single group of receptors of the secondary plant that can treat cancer through various modes of action (Besbes et al., 2004).

A different investigation determined several phytoestrogen compounds in date fruit, including genistein, daidzein, secoisolariciresinol glycitein, coumestrol, formononetin, lariciresinol, matairesinol, and pinoresinol (Thompson et al., 2006).

The date fruit contains numerous phytosterols, while date pollens and seeds contain the highest phytosterols amount (Duke, 2001). Phytosterols have been used to treat various health conditions related to hormones. The phytosterol types in the dates include brassicasterol, ergosterol, estrone, and estrogen (Ben-Amotz and Fishier, 1998). The main sterols recognized in the date edible parts were β-sitosterol, stigmasterol, isofucosterol, and campesterol(Kikuchi and Miki, 1978). In "Al-Zahidi" dates, the highest quantity of β-sitosterol was found, as well as avenasterol, stigmasterol, campesterol, and five-triterpenoid lupeol (lup-20 (29) en-3P-0l)(Al-Abid et al., 2006). Date seeds also comprise estrogen, brassicasterol, ergosterol, and estrone (Duke, 2000; Duke, 2001). However, campestrol, stigmasta-5,22-diane-3-a, β-sitosterol, 24-(Erubidenin-3-a), lupeol 24-methylene clenchlortanol, sigmastan-5-5-diene, and stigmast-4-en-3-1, cholesterol-4-n - 3-, 4-methylcholest-4-en-3-one, spinasterone, and cholesta-3,5-diene were identified in the edible portion of dates (Liolios et al., 2009).

Lupane types, including betulinic acid, lupeol, and betulin, act as anti-inflammatory and immunity modulators. Lupeol has reduced the progression of cancer in mice and levels of the prostate(Laszczyk, 2009). The prostate cell death in mice fed a mixture of an anti-Fas monoclonal antibody and lupeol (synergistic effect) was higher than the 2 compounds only (Saleem et al., 2005). On the other hand, phytosterols impact plasma, low-density lipoprotein (LDL), and total cholesterol. Generally, phytosterols are healthy food and cosmetics (Quilez et al., 2003).

Tocotrienols and tocopherols

Tocotrienols and Tocopherols compounds are found in the date's fruit's lipid part. Tocol (tocotrienol and tocopherol)

vary from the vegetable oil (Mrabet et al., 2020). Tocotrienols, phenolic, phytosterols, and Tocopherols compounds have been found in significant quantities in date palm (*P. dactylifera* L.) too (Mrabet et al., 2020). In a study, they discovered that ά-tocopherol acetate, which is the second vitamin E form, was described in the lipid part of the fruits of the date in moderate amounts (Al Juhaimi et al., 2018). It found that there are about (243.00 ppm) of ά-tocopherol in the oil of the seed in Khalas date variety which is greater in comparison with (198.00 ppm) in the palm kernel oil (Habib et al., 2013). And (Nehdi et al., 2010; Nehdi et al., 2018) conveyed that in the seeds of Tunisian date, ά-tocotrienols concentration was 34.01 mg/100g, γ-tocopherol was 10.30 mg/100g, and γ-tocotrienol was 4.63 mg/100g. Also, ά-tocopherol quantities were 38.85% and 24.97% in the seed of Allig and Deglet Noor date varieties (Besbes et al., 2004).

Antioxidants

The date's fruits can be considered functional foods, nutraceuticals, or functional foods constituent based on antioxidant ability (Maqsood et al., 2020). Incidentally, (Guo et al., 2003) suggested that the dates are considered the 2nd -highest antioxidant rate among the common 28 fruits eaten in China. In date fruit extracts, there is a linear association between the activity of antioxidants and total phenolic levels (Alliath, 2005). Additionally, Sun-dried dates from Oman, such as Khalas, Al Fard, and Khasab are a respectable source of antioxidant components, comprising selenium with a rate of 0.356 - 0.528 mg/100g. The total antioxidants ranged from 8,212 - 12,543 µl of Trolox equivalent/g. In comparison, the content of carotenoids ranged from 0.92 to 2.91 mg/100g and phenolics content by a mean of 217 - 343 mg of ferulic acid equivalents/100g. Recently, the results from antioxidant analyzes presented that the antioxidative capacity of date varieties examined by ABTS, DPPH, ORAC, and FRAP are greatly various. The radical scavenging ability against DPPH of the antioxidants was lesser than those of ABTS scavenging activity, indicating the components of date varieties react inversely with the chemical compounds complicated in diverse protocols of antioxidant analysis (Al-Jasass et al., 2015). In rats, the date extracts were enhanced by the phosphodiesterase enzyme, catalase and glutathione peroxidase capacity, and pathological changes in trichloroacetic acid in the liver (El Arem et al., 2014).

Volatile odors

About 80 volatile components have been isolated from date fruits, such as 1 lactone, 6 ketones, 10 terpenes, 12 hydrocarbons, 13 aldehydes, 20 esters, and 19 alcohols. These volatile constituents represent 90.7-99.6% of the total volatile odors in dates. The amount of aromatic compounds varies according to the different date varieties and maturity stages. In addition, Other volatile compounds such as phenyl ethyl alcohol,2-propanol, isoamyl acetate, and isoamyl alcohol have been detected in Tunisian dates (Guido et al., 2011). All volatile compounds are categorized by an odor limit (ranging from ppm from ppb to several parts per million). Alcohol, terpenes, aldehydes, and ketones were known by the citrus, floral, and fruity properties of the dates' aroma (Richard, 1992). It has been suggested that two straight-chain aldehydes, anamorphic and capillary, are responsible for the slightly fresh greenish of the dates. Also, aliphatic alcohols or terpene are categorized by herbal, citrus, fruity, floral, and fungal aromas (Richard, 1992).

Among the components isolated in the date pulp are 14 esters (23%), 10 alcohols (17%), 4 lactones (8%), 8 aldehydes (15%), and 3 ketones (3.5%). The main volatile chemicals which exist in dates are isopropyl acetate, ethyl acetate, acetaldehyde, octanal alcohol, furfuryl, 5-methylfurfural, 6-valerolactone, linalool, 6-valerolac, and unicalactone. The formation of flavors and aromatic components in dates is dynamic because they are constantly synthesized and established during the growth and ripening stages. Therefore, the qualitative and quantitative volatility is changed. Generally, about 100 compounds have been identified in date fruits during ripening stages which belong to ketones, alcohols, esters, aldehydes, terpenes, and lactones (Jaddou et al., 1984, Reynes et al., 1994, Torres et al., 1996).

THE NUTRACEUTICAL POSSESSIONS AND HEALTH BENEFITS OF THE FRUIT OF DATE PALM

In general, the fruits of dates are an outstanding resource of several important phytochemicals like flavonoids, carotenoids, phytosterols, tannins, and phenolic acids (Hong et al., 2006; Guido et., 2011; Maqsood et al., 2020). These compounds could promote their pharmacological benefits, including alleviation of constipation, intestinal disorders, heart problems, anemia, cancer, impotence, diarrhea, and other conditions (Idowu et al., 2020). Furthermore, it was found that dates had anti-tumor activity, especially against pancreatic cancer, anti-parasitic, anti-microbial, anti-lipidic activities, and improvement of the immune system and antibiotics regulation (Ishurd and Kennedy, 2005; El Arem et al., 2014; Eid et al., 2015; El-Far et al., 2019). Besides, the dates had anti-hepatic, hepatoprotective, and renal effects (Ateeq et al., 2013), and they could improve the reproductive system (Bahmanpour et al., 2006; Ali et al., 2009). The Nutraceutical properties, antioxidant activity and the healthy use of the fruit date palm are summarized in Table 3.

Antioxidant activity

Date fruit extracts can prevent protein peroxidation and oxidation in addition to hydroxyl radical's inhibition. The

Table 3: The Nutraceutical properties, Antioxidant activity and health benefits of date palm

Properties	Experiment types, Samples and conditions	Activity	References
Antioxidant activity	In-Vitro studies - Algerian dates - Tunisian date, using water solvent - Tunisian date, *Allig*, *Kentichi* and *Deglet Nour*	TAC 88.59-205.47 mg GAE%FW). DPPH 51.26%- 89.08%. TAC 17.49-39.94 mg EAA% DPPH 57.54% to 90.12%. TCA 118.75-135.97 mg EAA%FW, DPPH 27.97 (*Allig*) to 76.40%	(Eid et al., 2013) (Kchaou et al., 2013) (Abbès et al., 2013).
	In-Vivo study (Date water extracts) Dried dates "Dijla Nour" and "Al-Zahidi" In vitro experiment, the dates water extracts In-vivo dates water and methanol extract. Freund's-induced arthritis model in rats. Water data extract (4 ml/kg/day) Date (Phoenix dactylifera L.) fruit phenolic-acid or flavonol fractions were examined in vitro. In the human subjects, "Hallawi" variety	- Inhibited ROS, lipid peroxidation, protein oxidation, and lipoprotein oxidation. hydroxyl radical and superoxide oxygen - Inhibit the oxidation of LDL and (VLDL) with (1/IC5) about 2.17 by 5 times higher than that of vitamins E and C. - Inhabitation of H_2O_2-induced programmed cell death and cell damage. - Improved serum antioxidant by enhancing vitamins E, C, retinol, and β-carotene, decreasing the maltonaldehyde - The antioxidant capacity of glutathione peroxidase, catalase, and superoxide dismutase protects kidneys tissues and regulates their functions. - Reduce ferric ions, scavenge radicals, and inhibit LDL oxidation. - Better inhibition against LDL oxidation - Lowered oxidative stress by 33% , enhanced antioxidant enzyme activity such as paraoxonase arylesterase.	(Vayalil 2012) (Vinson et al., 2005) (Asadi-Shekaari et al., 2008) (El Arem et al., 2014) (Borochov-Neori et al., 2015) (Rock et al., 2009).
Glucose-Lowering Potential	Generally Human study In healthy subjects. In healthy volunteers. Consumption of date glycosides by diabetic mice. Consumption of date extracts for six weeks in D. rats. In humans, dates seeds Date extracts administration by STZ-induced (T2DM) rats for a month. Several in-vivo studies, dates. In vivo, Saudi date seed extract on STZ-induced diabetic rats.	- low Glycemic Index (GI) diet is associated with reduced risk of developing non-insulin diabetes in men. - the stimulation of insulin secretion 2.7 times - Lowered glucose levels resulted in an acute insulin response compared to dextrose. - Development of blood glucose, lipid profiles levels, and liver function - Impaired exploratory activity prevented a decrease in nerve diameter of the diabetic rats. - Exhibited protective effects against complications of early diabetes in both liver and kidneys. - Significantly decreased glucose levels increase insulin concentration. - Reduced blood glucose (HbA1c) and improved insulin secretion as compared to the diabetic group. -Anti diabetic, hypolipidemic, antioxidative	(Rock et al., 2009) (Ahmed et al., 1991, Mohammed et al., 1998) (Famuyiwa et al., 1992) (Michael et al., 2013) (Michael et al., 2013) (Michael et al., 2013) (Saddi et al., 2018) (Zaakouk et al., 2018) (Victor 2017) (Ahmed et al., 2017) (Hasan and Mohieldein 2016)
Hypocholesterolemia lowering activity	The consuming date fruits. In mice, In rats, the consumption of pomegranate, date fruits, and date seeds. Intake 100 g of Hallawi or Majdool dates by humans for 4 w. Ajwa, Hallawi dates. Date (Phoenix dactylifera L.) fruit phenolic-acid or flavonol fractions were examined in vitro.	Effectively lower serum triglyceride and cholesterol, increase paroxonase (PONl) activity, and reduce the pressure of oxidized peritoneal macrophages (MPM), MPM cholesterol, and MPM LD absorption. - Lipid peroxide was reduced, and the activity of PON lactonase increased. - Showed anti-E (0) effects on serum E (0), macrophages, and aorta. - Led to lowered blood triglycerides. - Lowered cholesterol, LDL and TG in serum The flavonol fractions stimulated cholesterol removal from macrophages.	(Rosenblat et al., 2015) (Rock et al., 2009) (Batool et al., 2020) (Borochov-Neori et al., 2015)

(Contd...)

Table 3: ***(Continued)***

Properties	Experiment types, Samples and conditions	Activity	References
Anti-cancer/tumor activities	The glucans of dates Human studies A randomised, controlled, cross-over, human intervention study, Date palm fruits. Ajwa date (Phoenix dactylifera L.) extract, in vitro. Ethyl acetate fraction of Phoenix dactylifera L.(Ajwa dates).	- Inhibit the growth of the tumor, and the change was a dose-dependent activity, the tumor inhibition by glucans was found in the tumor later stages of progression, indicating an indirect effect of these glucans - Lowered the genotoxicity in the water of the fecal human. Preventing the proliferation of colon cancer cells. - Inhibits human breast adenocarcinoma (MCF7) cells *in vitro* by inducing apoptosis and cell cycle arrest - Induction of apoptosis and cell cycle arrest in prostate cancer cells	(Ishurd and Kennedy 2005) (Eid et al., 2014) (Eid et al., 2015) (Khan et al., 2016) (Mirza et al., 2018)
Antimicrobial activity	Antibacterial activity Antifungal activity Antibacterial activity Anti-viral activity	*Bacillus subtilis, Pseudomonas aerugino Salmonella typhi, and Staphylococcus aureus. Streptococcus mycotoxins Albicans fungi* or *Candida albicans* Against *Listeria monocytogenes* and that *Staphylococcus aureus* Against *Salmonella typhi, Pseudomonas aeruginosa Bacillus subtilis, Enterococcus faecalis), Escherichia coli, Bacillus cereus, Staphylococcus aureus, Serratia marcescens and Shigella spp*. Against lytic Pseudomonas phage ATCC 14209-B1, reducing phage activity and totally inhibiting bacterial lysis.	[(Al-Daihan and Bhat 2012) [(Hammad and Sallal 2002) (Sallal et al., 1996) (Shraideh et al., 1998) (Abu-Elteen 2000) (Aamir et al., 2013) (Sallal and Ashkenani 1989) (Samad et al., 2016) (Daoud et al., 2019) (Jassim and Naji 2010)
Protection against tissue damage	In-vivo studies, in rats, Dates pulp extract and palm sap (Phoenix dactylifera L.) Date syrup–derived polyphenols, in endothelial cells. In-vivo, Date seed (*P. dactylifera*) extract in hypercholesterolemic rats. In-vitro studies.	-Treatments for sore throats and mucus membranes. Date fruits have strong anti-inflammatory characteristics and are used in the inflammatory diseases treatment. -The components of dates was exposed to have anti-inflammatory activity. - In plasm rats, dates reduced erythrocyte sedimentation and fibrinogen compounds. - Date seeds enhanced the effect of serum paraoxonase and arylesterase. - The Saudi date fruits (aqueous and methanol extracts reduce COX-1 enzyme and prevent the occurrence of inflammatory intermediates	(Souli et al., 2014), (Yasin et al., 2015) (Taleb et al., 2016) (Al-Daihan and Bhat 2012) (Takaeidi et al., 2014) (Zhang et al., 2017)
Gastrointestinal and liver diseases	Human studies Aqueous date fruit extract, in rats. Date palm fruit extract, on dimethoate induced-oxidative stress in rat liver. And in dogs. In vivo, Seed extract, on STZ-induced diabetic rats.	- Hepatoprotective and Anti-inflammatory activity - Neurological effects - protective effects against hepatotoxicity induced by carbon tetrachloride and methanoate - Play a major role in protecting liver cells from oxidizing factors that oxidize fats and proteins of the liver cell and break down the cell wall and DNA, which damages liver cells. - Also it reducing oxidative stress, prolonged consumption of Ajwaseed extract maintain kidney and liver function	(Ali et al., 2009) (Majid et al., 2008) (Saafi et al., 2011, Abdelrahman et al., 2012) (Al-Alawi et al., 2017) (Hasan and Mohieldein 2016)
Traditional medicine	-Diabetes in Morocco . -Traditionally, date fruits have been administered in the treatment of inflammatory diseases, digestive problems, asthma, and edema		(Tahraoui et al., 2007) (Yasin et al., 2015)

(Contd...)

Table 3: ***(Continued)***

Properties	Experiment types, conditions	Samples and Activity	References
Fertility	In Egypt In Sudan In rats. In human	*Date*+bee-honey and ginger increase fertility Adverse effects on the gonads and sperm. Increase the level of estrogen in the blood plasma and help produce eggs properly because they contain vitamins (A, B)	(Khare 2007) (Saleem et al., 2005) (Mehraban et al., 2014) (Saryono and Rahmawati 2016)
Additional Nutraceutical properties and health benefits	In mice that have been used as a model of ischemic injury. Aqueous date fruit extract on focal cerebral ischemia in rats.	- Reduced skin wrinkling in women Anti-aging and. - Beneficial health effects on pregnant and lactating mothers. - Neuroprotective - Relieve dry cough, lethargy, headaches, mild fever in addition to appetite loss. - Eye problems treatment in Morocco. - In reducing symptoms of diseases. - As anti-hypertensive - Neuroprotective and hemolytic potentials	(Bauza et al., 2002) (Puri et al., 2000) (Zaid and Wet 2002) (Ali et al., 2009) (Majid et al., 2008) (Takaeidi et al., 2014) (Maqsood et al., 2020) (Pujari et al., 2011)

Total Antioxidant Capacity=TAC

date fruit's antioxidant properties are linked with numerous medicinal possessions like nephrotoxicity protection, hepatoprotective effect, and neuroprotective effect (Allaith 2008). The ant-oxidative effects of the palm dates are referred to as the carotenoids, polyphenols, and selenium contents. Selenium act as an activator for several enzymes associated with the detoxification of reactive oxygen species (ROS)(Zoidis et al., 2018). Oxidative stress in the body is linked to many diseases. It is defined as a state of imbalance between oxidizing and antioxidant factors inside the human body. During the generation of the energy compound Adenosine triphosphate ATP within Mitochondria in the electron-transformation chain produce oxidizing agents as by-products, including the ROS for instance, hydrogen peroxide (H_2O_2), hydroxyl radical ($^{\bullet}OH$) and superoxide $O_2^{\bullet\bullet}$. It is stable because it contains an unpaired electron in the outer orbitals, which leads to a rapid reaction in the body through oxidation (removal of an electron) from other atoms or giving the extra electron to another atom to return to the stable state (Adwas et al., 2019).

The cell works to produce antioxidants such as non-enzyme compounds and antioxidant enzymes to restore the optimal balance between oxidizing and antioxidant factors that bind to free radicals and work to neutralize their work, thus stopping the damage to the body and natural antioxidants in foods enhance this process. High oxidative stress leads to high levels of oxidative damage, which is the damage that occurs to cells as a result of the oxidation of unsaturated fatty acids which make up the membranes of cells and the formation of highly oxidized lipid peroxide, which in turn affects the vital molecules associated with fats such as protein and cholesterol and works to attack the membrane proteins, thus causing a change in The permeability of the membranes and the functions of the receptors in them, which facilitates the access of free radicals into the cells to attack other compounds, causing a disturbance in the cellular function (Qureshi et al., 1991; Robak and Gryglewski, 1996; Bagchi et al., 2000). Lipid peroxide also breaks down the DNA inside the cell. Thus, oxidative stress plays a significant role in the emergence of numerous illnesses like atherosclerosis, ischemic heart disease, diabetes, arthritis, liver disease, and cancer (Halliwell and Whiteman, 2004).

Stress, psychological stress, immune disorder, and cancer diseases are among the stimulating factors to increase the free radicals formation inside the body and are responsible for changes within cells. Water and air pollution, drinking alcohol, smoking, some medications, heavy metals, exposure to radiation, and pesticides are among the external factors that stimulate their formation. Dates and date kernels contain different proportions of compounds that play an imperative role in ridding the body of these free radicals, as they act as antioxidants such as phenolic substances, alkaloids, flavonoids, antioxidants, and vitamins. Examples of these components are anthocyanins, flavonoid glycosides, proanthocyanidins, and procyanidins found in dates, in addition to β-carotene (Allaith 2008; Baliga et al., 2011). In general, an important relationship was found between the antioxidant capacity and the level of total phenol in numerous cultivars of date, indicating that phenols are the main contributor to the antioxidant capacity of date fruits (Mansouri et al., 2005; Allaith 2008; Borochov-Neori et al., 2015).

The aqueous extract from dates showed a strong free radical inhibiting ability against ROS such as superoxide O_2 and OH radical (Vayalil, 2012). At the same time, the fresh date's aquatic extract showed a sturdy inhibitory effect on the reactive oxygen species, lipid peroxidation, and protein oxidation. It also displayed a high inhibition influence on the in vitro molecular injuries like the oxidation of protein and lipoprotein. Moreover, (Vinson et al., 2005) found that the level amount of the extracts required to inhibit the oxidation of LDL and very-low-

density lipoprotein (VLDL) with sulfur ions is (1/IC5). It was about 2.17 in dried dates such as Dijla Nour and Al-Zahidi, five times higher than vitamins E and C. However, the date fruits' antioxidant activity varies according to the level of phenolics, carotenoids, flavonoids, and vitamin E (Mansouri et al., 2005). In general, Dried date varieties such as "Zahidi" and "Deglet Nour" have antioxidant capacities 5 times higher than that of vitamin or E vitamin C (Vinson et al., 2005). In vitro experiment, the water extracts from dates showed inhabitation of H_2O_2-induced programmed cell death and cell damage in a level-reliant way in the cell lines, indicating the powerful ability of extracts against cell death induced by free radicals (Asadi-Shekaari et al., 2008).

Furthermore, water and methanol extract from dates improved the blood antioxidant level by the augmenting of β-carotene, vitamins C, E, and retinol, along with decreasing the malonaldehyde concentrations in the arthritis model Freund's-induced rats. Additionally, water data extract (4 ml/kg/day) showed particular significant alteration by trichloroacetic acid oral administration in drinking water (0.5 and 2g/L) by improving the antioxidant capacity of glutathione peroxidase, catalase, and the activity of superoxide dismutase returned to normal by oxidation. It was found that the content of malondialdehyde protects the tissues in the kidneys and regulates their functions. It can be concluded that water extract of date fruit has a protective role against the oxidative stress caused by trichloroacetic acid and thus protects renal tissues from damage caused by trichloroacetic acid (El Arem et al., 2014). The fractions of flavanol from Halawi and Omari varieties showed significantly better inhibition against LDL oxidation (Borochov-Neori et al., 2015). Furthermore, the "Hallawi" variety lowered oxidative stress in the human subject by 33%, as detected by various approaches supported by improved serum antioxidant enzyme activity such as paraoxonase arylesterase(Al-Shahib and Marshall, 2003). Generally, a significant relationship has been found between antioxidant capacity and total phenolic level in numerous date varieties, indicating that phenolics are the main contributor to antioxidant capacity in the fruit of date (Mansouri et al., 2005; Allaith, 2008; Borochov-Neori et al., 2015).

The flavonoids, polyphenol rates, antibacterial and antioxidant actions of diverse palm pollen's extracts that were collected from Tunisian palm cultivars (Tozeur and Kerkennah) using other solvents, including hexane, chloroform, ethyl acetate and acetone, Ethanol, and water. The results showed that the pollen content of Tozeur palm from TPC is higher than that of Kerkennah for all extracts except the hexane extract. The phenolic compounds extracted are rutin, coumarin, catechin, caffeic acid, gallic acid, vanillic acid, epicatechin, and quercitin (Daoud et al., 2019).

Glucose-lowering potential

The Glycemic response of the foods is a degree of the ability of the food to increase the level of sugar in the blood. Food combinations with low Glycemic Response foods decrease insulin responses and postprandial blood glucose. Epidemiologic studies dating back to the period of the introduction of glycemic response suggested that a small Glycemic Index (GI) diet is related to a lowered danger of insulin-independent diabetes increasing in men (Salmeron et al., 1997) and women (Wolever et al., 1991). Clinical studies in diabetic, hyperlipidemic, and normal subjects showed that small Glycemic Response diets diminish serum triglycerides, blood glucose levels, and insulin secretion in persons suffering from hypertriglyceridemia (Salmeron et al., 1997). Furthermore, the carbohydrate digestibility in the lower Glycemic Response foods is usually fewer than the digestibility of the highest Glycemic Response foods. Consequently, small Glycemic Response foods raise the number of carbohydrates incoming into the colon and escalate the colonic fermentation process and the generation of short-chain fatty acids.

Consummation of foods containing homogeneous amounts of carbohydrates for energy leads to different blood sugar levels and insulin responses (Vayalil, 2012). GI is the blood sugar index, and it is defined as an indicator of the effect of diet on the response of the postprandial glucose (Wolever et al., 1991). GI value is affected by numerous influences, like the sugar type, particle size, and nature of nutritional components such as fiber, fat, protein, and processing method (Jenkins et al., 1981; Wolever et al., 1991). Although the fruit of dates is rich in sugars, few reports indicated that some varieties have similar GI values to other fruits, such as oranges and apples (Vayalil, 2012). (Lock et al., 1988), found that date GI in pregnant women with diabetes was 61.1. However, this effort didn't consider significant factors such as date varieties, maturity stage, and carbohydrate ratio. Thus, the dates have no adverse effect on glucose tolerance in healthy persons. In the clinical studies, the additional Incremental area under the curve (IAUC) after consuming the meal of Khalas date was best significantly considering glycaemic index maintaining (57.7 mg/dL) versus (79.0 mg/dL) of Saudi breakfast meals such as hot milk, organic juice, Arabic bread boiled egg and Arabic coffee (Ahmed et al., 1991).

Moreover, the glucose IAUC after consumption of dates was significantly smaller than that of dextrose. Furthermore, the insulin IAUC in patients next to consumption of grape sugar and dates was not significantly changed. In healthy subjects, the stimulation of insulin secretion after consumption of dates was 2.7 times lower than that of dextrose. Likewise, the C-peptide insulin values were lowered after consuming glucose-containing

food or dates with a Saudi breakfast meal than the Saudi meal or glucose (Ahmed et al., 1991; Mohammed et al., 1998). Consequently, they established that the meal of date is a helpful regime for diabetic voluntaries compared with traditional Saudi breakfast. According to (Famuyiwa et al., 1992), administering equal quantities of "sugary" dates in the date stage significantly lowered glucose levels in healthy volunteers. It resulted in an acute insulin response compared to their response to dextrose.

Whereas in healthy people, the mean GI for "Bu Ma'an" and Al- Khalas dates were 30.5 and 35.5, respectively (Miller et al., 2003), for Al- Khalas with yogurt, the average GI was 35.5. In healthy people, the GI ranged between 31 and 50, depending on the date varieties, whereas it decreased to 29 or 47 when the dates were consumed like a portion of a miscellaneous meal (Miller et al., 2003; Dayang et al., 2014). One of the international databases mentioned that the GI for desiccated dates from Australia was about 103, which was dramatically greater than that of date fruits from certain further nations (Denyer and Dickinson 2005). What is more, (Ranilla et al., 2008) stated that the consumption of dates may impede the partial or completed digestion of further sugars fed concurrently, decrease glucose uptake and blood level, leading to lesser the GI of the food that has a high GI. (Alkaabi et al., 2011), reported that healthy subjects' average GI in dates were 55.1, 54.0, 6.1, 53.5, 49.1, and 46.3 for Al-Ikhlas, Al-Fard, Lulu, Debbas, and Bu Maan, respectively. The feeding of previous varieties by Type 2 diabetic patients led to a very similar GI to the earlier rates (46.1, 43.8, 51.8, 50.2, and 53.0). The results showed that the GI of the five varieties included in this study decreased, and their feeding by diabetic patients would not lead to the conversion of food into glucose sugar; this may be related to the high dietary fiber and fructose content (Foster-Powell et al., 2002), reported that some varieties are low in sugar, indicating the possible benefits of this fruit for diabetic patients when it added into and balanced diet. It has been reported that the rate of variation in the different varieties in Oman ranges between 47.6 and 57.7 (Ali et al., 2009). (AlGeffari et al., 2016), report the GI for 17 types was 42.8–74.6. The highest values were found in the *Sellaj* and *Um-Kabar* varieties, while the lowest values were found in the *Ajwah* and *Shaqra* varieties. This indicates that regular date consumption may not lead to chronic disease improvement. Therefore, they could be a suitable carbohydrate source for both a healthy and diabetic individual (Alkaabi et al., 2011, AlGeffari et al., 2016). The presence of high levels of fructose in fruit dates may have beneficial effects on human health, such as preventing or delaying chronic diseases development because fructose significantly reduces postprandial blood sugar by improving the glycogen synthesis as well as the hepatic glucokinase (Van Schaftingen and Davies 1991; Shiota et al., 2002; Watford 2002). The reason may be due to low GI values on dates. Despite the dates having high sugar levels, numerous variations are still appropriate to little GI food. According to mentioned studies and the published data, it is possible to refute the hypothesis that the effect of date consumption is similar to that of sweets. Regularly consuming dates can lead to chronic disease development (Vayalil, 2012).

The consumption of date glycosides by diabetic mice showed significant development in blood glucose levels, lipid profiles, and liver function (Michael et al., 2013). For chronic diseases, consuming these extracts for six weeks resulted in impaired exploratory activity and prevented a decrease in the diameter of the nerve of the diabetic rats (Zangiabadi et al., 2011). Furthermore, date seeds were utilized for diabetes treatment in traditional medical treatment for several years. Some studies have stated an anti-diabetic activity of date seeds. Nevertheless, their influence on complications of diabetes is still unclear. Recently, it was found that the extract of dates seeds exhibited protective effects against complications of early diabetes in both the liver and kidneys. This ability may be attributed to the antioxidant capacity of date seeds (Abdelaziz et al., 2015).

In a study, the extracts of date *(P. dactylifera)* were consumed by STZ-induced diabetes mellitus type 2 (T2DM) rats for 30 days, a significant diminution ($p < 0.001$) in the concentration of glucose in addition to elevation of insulin level (Saddi et al., 2018). Heglig dates (Balanites aegyptiaca) lowered glucose levels in the blood by (209.4 mg/dL compared with. 410.2 mg/dL) also, the concentration of the hemoglobin A1c (HbA1c) was increased to (8.1) compared with (6.7) the insulin secretion enhanced to (1.2) as compared to (1.9) in control (untreated) diabetic group (Zaakouk et al., 2018). The probable mechanism of antidiabetic effects of dates may be attributed to the phytochemicals such as flavonoids that may enhance β-cells numbers and ameliorate insulin secretion (Victor 2017). In additional in vivo research (Victor, 2017), the diabetic rats were fed by the fruit pulps of *P. dactylifera*. Blood glucose was reduced significantly compared with the diabetic untreated and control rats. It is supposed that the possible mechanism is due to the gastric emptying reduced by the effects of date fruits polyphenols (Evans et al., 2018). The results point out that the pulp of date fruit possesses glucose-lowering potential. Consequently, (El Abed et al., 2017) established that the extracts of date fruit decreased glucose concentration in plasma significantly ($p < 0.01$) from 214.0 to 157.2 mg/dL in comparing with the acarbose in the diabetic albino mice.

In additional work, in Pakistan, the Aseel native date variety was orally eaten by 32 hyperglycaemic, and

normoglycaemic Sprague-Dawley rats with (300 and 600 mg/kg) an insignificant reduction in blood glucose of the normoglycaemic rats were shown, even though in hyperglycaemic rats those alterations were found significantly at $p < 0.005$, from 281.4 ± 8.0 to be 203.2 ± 12.0 mg/dL) (Ahmed et al., 2017).

A Critical Review by Mia et al. (2020) concludes that dates not only decrease glucose levels and the GI of T2DM but relieve complications from diabetes. This is due to the contribution of polyphenols, flavonoids, and antioxidants in dates to lower glucose levels. He suggested four possible mechanisms, which are (1) cell stimulation, (2) elevate the islets and cells number, (3) reduction of cell apoptosis and the carbohydrate hydrolysis through α-amylase inhibiting (4) enhancing the activities of α-glucosidase, and (5 Decreased the absorption of glucose in the intestine.

Hypocholesterolemia lowering activity

Date fruit has been found to comprise components that can regulate hypercholesteremia (Alsaif et al., 2007). The dates supplementation into the diet of hypercholesteremic hamsters decreased the total triglycerides, cholesterol, and LDL-C in plasma significantly, while organ weights tissue lipid levels did not change by dates supplementation. These results may modify cholesterol absorption or metabolism by date fruit supplementation, thus preventing coronary heart disease and atherosclerosis. The polyphenol tannins in pomegranate and the phenolic acids in fruits and seeds of date are considered effective antioxidants and anti-atherosclerotic agents. Thus, consuming the mixture of these two fruits can effectively lower the serum levels of triglyceride and cholesterol and increase serum paraoxonase (PONl) activity. This mixture also significantly reduced the pressure of oxidized peritoneal macrophages (MPM), MPM cholesterol content, and MPM LD absorption. In mice, the lipid peroxide was significantly reduced, and the activity of PON lactonase was increased by the consummation of these two fruits mixture. In rats, the consumption of a mix of pomegranate, date fruits, and date seeds showed anti-E (0) effects on serum E (0), macrophages, and aorta due to its unique and diverse structure (Rosenblat et al., 2015). Humans' intake of 100 g of Hallawi or Majdool dates for four weeks lowered blood triglycerides. In contrast, the body mass index, total cholesterol, LDL, HDL, VLDL, and glucose serum did not modify by dare consumption (Rock et al., 2009). According to (Batool et al., 2020), Ajwa and Hallawi dates were found to have the potential to lower cholesterol, LDL, and TG in serum.

Anti-cancer/tumor activities

It was discovered that dates have anti-tumor activity as dates can lower the rate of cancer, activate the immune system, and regulate the role of antibiotics. Research has shown that dates have a strong potential to scavenge free radicals and thus limit the development and progression of cancer. Dates are rich in carotenoids, tannins, sterols, and polyphenols such as phenolic acids, flavonoids, lignans, and (1-3) beta-D-glucans (1→3)-β-D-glucans, and these compounds give it anti-tumor and anti-cancer activity (El-Far et al., 2019). (Ishurd and Kennedy, 2005) and some researchers have revealed the antitumor activity of phytochemicals in date fruit resulting from the presence of glucans in them that reduce tumor growth depending on the dose, where optimal antitumor activity appears at a dose of 1.0 mg. For antitumor activity, there is evidence that the phytochemicals of date fruit have antitumor activity, for example, the glucans of dates could inhibit the growth of the tumor, and the change was a dose-dependent activity. The tumor inhibition by glucans was found in the later stages of cancer progression, indicating an indirect glucans effect (Ishurd and Kennedy, 2005). Several studies showed that the preventive cure of experimental animals by glucans extracted from dates 11 days before tumor inoculation was similar to treatment with gluconate. And concurrent with cancer cells, which indicates the possibility of stimulating the immune system in the fight against cancer.

It was found that the date consumption by healthy human volunteers led to a reduced prevalence of colon cancer partially mediated by interactions between polyphenols, and insoluble fibers, with gut flora. However, date consumption didn't persuade important alterations in the specific bacterial type's growth or short-chain FA production, a significant enhancement in the bowel movement and stool frequency, and significant decreases in ammonia in the stool. Furthermore, the intake of date fruits significantly lowered the genotoxicity in the water of the fecal human (Eid et al., 2015). On the other hand, other work reported that the consumption of date fruits might reduce the colon cancer risk without gut flora modification (Eid et al., 2014). A study by Khan et al. (2016) demonstrates the effects of date, Ajwa variety, on cancer therapy. Therefore, date fruits might be helpful as an adjunct therapy with conventional chemotherapeutics to achieve a synergistic effect against breast cancer. Consuming date fruits may enhance colon health by increasing the growth of beneficial bacteria and preventing the proliferation of colon cancer cells (Khan et al., 2016).

The consumption of date extracts for 7 days activated humoral immunity via enhancing antibody action and cellular immunity by improving the macrophage translocation index (80%) compared with control mice (Puri et al., 2000). Karasawa et al. (2011) showed that mice feeding with heated water extracts of dates improved the number of splenic interferons IFN-(+) CD49b (+), interleukin-12 (+) CD11b (+), and (IFN)-(+) CD4 (+)

cells. The mice's cellular immune system was stimulated by polysaccharides and polyphenols extracted from date fruit (Ahmad et al., 2013).

Studies have shown the anti-cancer effect of Ajwa date extracts on liver cancer, prostate cancer, and breast cancer in experimental animals infected with them. It was found that the aqueous extract of Ajwa has a role in restoring normal liver cells by improving enzymes and liver functions and restoring antioxidant enzymes. Also, alcoholic Ajwa extract (Ajwa) has potential therapeutic properties to reduce the development of cancerous cells in prostate tissue affected by cancer. Methanolic Ajwa date extract inhibits the growth and spread of cancer cells in the breast (Mirza et al., 2018). Recently, (Godugu et al., 2020) studied the protective role of nanocomposites derived from bioactive compounds in Ajwa dates, quercetin, and rutin against doxorubicin, which is often used as chemotherapy for breast cancer, which may cause cardiotoxic effects. The study concluded that the bioactive extracts of Ajwa protect against cardiomyopathy caused by DOX treatment, effectively reduced DOX-induced weight loss in the mice, and reduced the elevation of cTn-I significantly. Moreover, intramuscular injections of 5 mg (rutin + quercetin)/kg mixture for 11 days in mice reduced the histopathological changes in cardiomyocytes caused by DOX while not impairing the efficacy of DOX against DOX breast cancer (Godugu et al., 2020).

Anti-inflammation activity

Traditionally, date fruits have been administered to treat inflammatory diseases, digestive problems, asthma, and edema (Yasin et al., 2015). Date and its products, such as syrup and paste, have been reported to be helpful treatments for sore throats and mucus membranes (Souli et al., 2014). The anti-inflammatory potential was mainly modulated through phenolic compounds, namely flavonoids, caffeic acid, syringic acid, and ferulic acid (Jung et al., 2007, Das et al., 2015). Date fruits have strong anti-inflammatory characteristics and treat inflammatory diseases (Yasin et al., 2015, Taleb et al., 2016). As Anti-inflammatory activity, the components of dates have been shown to have anti-inflammatory activity. In plasm rats, the dates reduced the erythrocyte sedimentation and fibrinogen compounds, elevated by adjuvant drug (Mohamed 2005). Furthermore, the administration of extracts from date seeds significantly enhanced the effect of serum paraoxonase and arylesterase. Therefore, the date seed extract may be useful in reducing symptoms of diseases caused by reduced paraoxonase action (Takaeidi et al., 2014). An in vitro study was done to examine the anti-inflammatory effect of different Saudi varieties of date fruits using cyclooxygenase enzymes (COX-1 and -2). The date fruits (aqueous and methanol extracts, 100 μg/mL) showed COX-1 enzyme reduction by 26–36 and 33–41%, while the reduction in COX-2 was 45–48 and 48–52%, respectively. It concluded that the COX enzyme inhibition displayed the presence of compounds that might restrict the production of inflammation-causing hormones such as prostaglandins and thromboxanes in the date fruit extracts. This is likely achieved by preventing prostaglandin-endoperoxide production that prevents the occurrence of inflammatory intermediates (Zhang et al., 2017).

Antimicrobial activity

Date fruit has antibacterial effects such as *Bacillus subtilis, Pseudomonas aerugino Salmonella typhi, and Staphylococcus aureus* (Al-Daihan and Bhat 2012). Furthermore, the date fruit extracts could inhibit the growth of the pyogenic gene and neutralize the hemolytic activity of *Streptococcus mycotoxins* (Hammad and Sallal, 2002). As antifungal activities, the extracts of date have been found to encourage ability against *Albicans fungi* or *Candida albicans* (Sallal et al., 1996; Shraideh et al., 1998) by injuring cell membranes integrity, inducing cytoplasmic levels aggregation and separation of the plasma blastula from the wall of cell (Shraideh et al., 1998). The antifungal activity of dates is associated with their antioxidant capacities (Vayalil 2012). In the clinical studies, Abu-Elteen. (2000) treated three types of Candida in human epithelial cells (BEC) with the date extracts and examined the effect of mouth rinsing with date extracts on yeast bond to BEC. After yeast exportation to date extracts, the tested Candida had a low level of adherence to BEC. The Candida was also inhibited by preincubation of BEC with date extracts. Furthermore, Yeast adherence to BEC was reduced immediately or 5 to 20 min after rinsing orally with 10% extracts solution. The RBC of volunteers fed dates displayed resistance to the hemolytic activity of streptolysin O. In contrast, the titer of streptolysin O antibodies did not affect by date treatment. Accordingly, the inhibitor in dates might be a steroidal effect, and the neutralizing possessions occur by erythrocyte membrane inhibition and stabilization and the enzyme Strep-tolysin O, respectively (Hammad and Sallal, 2002).

Studies have also shown the role of date extract with different concentrations ranging from 10-20% in eliminating bacteria such as *Escherichia coli and Salmonella,* and Klebsiella pneumonia. The antioxidant actions of the date extracts were examined with DPPH and beta-carotene. The results showed that ethyl acetate extract from the pollen of Kerkennah palm had high effects against *Staphylococcus aureus* and *Listeria monocytogenes* that strain was most sensitive to Tozeur date pollen extracts, with MIC and MIC. All pollen extracts had strong inhibiting effects on (oxysporum) growth. Additional results showed the effectiveness of ethyl acetate extracts in inhibiting the *S. aureus*, and *L. monocytogenes* growth, respectively. Generally, the results indicate that

pollen can be counted as a talented source of novel natural antioxidants and antimicrobial material and to be utilized in numerous pharmaceutical and nutraceutical formulations and products. This indicates that the date extract is a respectable latent microbial growth inhibitor degrading food and might be a highly effective health beneficial option for plant, animal, and human infections. Date extract may expose novel auspicious occasions to develop highly effective, safe, harmless, and lucrative food preservatives to avoid food deterioration, antioxidant substances to mitigate cell damage caused by oxidative stress and the microbial plant infections, and nature antimicrobial for controlling numerous pathogenic agents in pharmaceutical and food industries and novel clinically efficient antibacterial substance (Daoud et al., 2019).

Wide arrays of anti-bacterial properties were described in diverse date cultivars from in-vivo and in-vitro research. For example, Ajwa dates extracted by acetone and methanol inhibit Gram-negative and Gram-positive bacteria (Shakiba et al., 2011; Aamir et al., 2013). Specific strains of bacteria such as *Salmonella typhi, Bacillus subtilis, Pseudomonas aeruginosa* were inhibited by date fruit's extracts (Sallal and Ashkenani, 1989) likely, *Enterococcus faecalis* (Aamir et al., 2013), *Staphylococcus aureus, Serratia marcescens, Bacillus cereus Escherichia coli* (Samad et al., 2016), and *Shigella spp* (Daoud et al., 2019). Date extracts can also act as a potent anti-fungal agent against *Fusarium oxysporum* (Daoud et al., 2019).

The date pit extracts have anti-viral activities, a very low concentration of<10 mg/mL, acetone-extracted date pits had anti-viral action counter to the lytic Pseudomonas phage ATCC 14209-B1, decreasing the activity of the phage and preventing the lysis of bacterial completely (Jassim and Naji, 2010).

Gastrointestinal and liver diseases

The human digestive system works to digest food and convert macronutrients and complex molecules into smaller absorbable molecules. The liver is the largest gland in the human body and is an accessory of the digestive system. It plays an important role in digesting food, producing and storing energy, and ridding the body of toxins. Liver diseases are considered one of the most common diseases globally. The causes of liver diseases are genetic factors, immune disorders, infectious diseases, or cancer (El Arem et al., 2014; El Arem et al., 2014). Date extract and palm pollen have been used to treat liver diseases in many countries. Studies conducted on experimental animals have proven that dates have a role in the prevention of liver diseases due to their high content of phenolic substances, vitamins, selenium, and zinc, which play a major role in protecting liver cells from oxidizing factors that oxidize fats and proteins of the liver cell and break down the cell wall and DNA, which Damage to liver cells (Al-Alawi et al., 2017). Jaundice and swelling are among the most important symptoms of liver disease, and the antioxidants in dates contribute to protecting the liver from the factors that cause liver poisoning. Like carbon tetrachloride CCl4, it also reduces liver enzymes (ALT, aspartate transporter AST, alkaline phosphatase ALP, gamma-glutamyl transporter peptide GGT). It helps the liver restore its normal function, lowering bilirubin levels, the bile that causes the appearance of bile Symptoms of jaundice (Attia et al., 2016; Khalid et al., 2017; Mallhi et al., 2018). Some studies have shown that the components of dates from proanthocyanidin, flavonoids, cyanidin, β-carotene, β-sitosterol, and selenium from Dates in Hama all have anti-ulcer properties (Attia et al., 2016; Khalid et al., 2017). Dates also act as a natural laxative because they contain fibers that absorb water and speed the passage of waste in the digestive system (International Diabetes Federation, Atlas, 5th ed., (2012) (update).). Studies have found an increase in LDH-Lactic Dehydrogenase in commercial animals that have been exposed to liver tissue damage, which is an indicator of cirrhosis or acute liver infections, and that treating these animals with date extract for two months led to a significant decrease in the rate of this enzyme in Blood (Al-Rasheed et al., 2015). Studies have also proven the effectiveness of dates in reducing the incidence of non-alcoholic fatty liver in experimental animals. Histological examination of liver tissue samples of experimental animals suffering from acute and chronic liver diseases who were treated with date extract for four weeks showed an improvement in liver tissue and the return of cells to their normal state (Al-Rasheed et al., 2015). Antiulcer activity, ethanol, and water extracts from dates alleviated the gastric ulceration severity, histamine, mucin levels of the gastric mucosa, and ethanol-induced plasma gastrin levels (Al-Qarawi et al., 2005).

Dates as traditional medicine

Populations know the nutritional and medicinal properties of dates of MENA. In traditional medicine, the dates are suggested for liver disease treatment and in pregnant women and after childbirth feeding (Al-Mamary et al., 2014). Additionally, dates are considered a common stimulant in the traditional Indian system of Ayurvedic medicine (Puri et al., 2000). As stated by Duke University, the date fruit is an analgesic, expectorant, nutritious, emesis, aphrodisiac, laxative, treatment of tuberculosis, coughs, gastroenteritis, asthma, and respirational illnesses (Duke 2001). Besides, the date fruits are widely utilized in traditional medicine for hypertension and diabetes treatment (Tahraoui et al., 2007). The dates alone, or combined with other plants, were utilized in traditional medicine to alleviate coughing, bronchitis, fainting, burning, and other injuries (Duke 2001, Al-Mamary et al., 2014).

In Palestine, the administration of three to four date fruits per day is directed for memory enhancement. While in Turkey, the Hurma coffee, made from the seeds of date fruit like plant coffee, is used up for memory-improving purposes (Daoud 2008, Sekeroglu et al., 2012).

Dates as a protective agent against tissue damage

Dates are one of the important agents for effective detoxifying, thus protecting tissues against toxins effects. For example, the extracts of dates (50% w/w) successfully lowered plasma urea and creatinine concentrations and the degree of kidney's damage caused by gentamicin. Furthermore, extracts of this fruit improved CCI4-induced hepatotoxicity (Al-Qarawi et al., 2004; Al-Qarawi et al., 2008). In addition, these extracts have been found to reduce hepatotoxicity by decreasing the amino-aspartate-transferase (AST), bilirubin, alkaline phosphatase (ALP), and alanine aminotransferase (ALT) concentration. In rats, thioacetamide-induced hepatotoxicity was improved by date fruit consumption. Finally, the aqueous extracts of dates successfully lowered cirrhosis by alleviation of thioacetamide, which encouraged the advancement of plasma AST, bilirubin ALT, and lactate dehydrogenase (LDH), in addition to the transfer of the glutamyl (GGT and ALP) (Ahmed et al., 2008).

Likewise, the extracts from date fruit showed protective effects against hepatotoxicity induced by carbon tetrachloride and methanoate (Abdelrahman et al., 2012). In addition, the date palm extract treatment repaired liver injury produced by TCA trichloroacetic acid, as evidenced by inhibiting the peroxidation of lipid in the liver (El Arem et al., 2014). Furthermore, date extracts could remarkably alleviate the liver disease by inhibiting oxidative stress caused by the free radicals. This may be attributed to the date's phenol and pranocanidine (Ahmed et al., 2016). Thus, the date seeds can act as a good source of food additives, natural antioxidants, or nutritional supplements to enhance life quality. In conclusion, a clinical study to evaluate the effect of date seed extracts on oxidative stress and stress-related liver disease is needed.

Fertility

The reproductive system is responsible for the reproductive process for the continuity of the human race. With the progress of science, studies have begun to reveal to us the impact of nutrition on the health of the reproductive system, as there are foods that have a good effect on the human reproductive system in terms of maintaining its safety or working to increase its fertility and help in the success reproduction process. Dates are one of these foods in addition to date palm pollen. Dates have been used as a natural factor to improve fertility, as traditional medicine has shown that palm pollen can enhance fertility factors. Some scientific studies conducted on dates have proven that it has a significant role in sperm formation and improving the level of testosterone in males and the level of the stimulating hormone Follicle Stimulating Hormone-FSH, where this hormone in males regulates sperm production, and Luteinizing Hormone LH, which regulates the function of the reproductive system and testes in males, due to dates containing effective compounds such as antioxidants, the most important of which are flavonoids, phenols, vitamins A, C and E (A, C, E), as well as the element selenium, as it can protect the membranes of sperm cells from oxidation and damage, which leads to a decrease in the percentage of dead sperm and maintain the proper cellular composition of sperm. One of the experimental studies on male experimental animals demonstrated that dates increase Sperm velocity and number. A study indicated that the aqueous extract of dates prevents damage to the cells of the testicles as a result of oxidation and maintains the health of the seminal ducts, thus reducing the incidence of infertility resulting from damage to the cells of the testicles in males (El-Kott et al., 2014). Dates also contain phytosterol and phytoestrogens, which work to increase fertility in women. Phytoestrogens have been observed in the amniotic fluid and umbilical cord blood. This compound improves female estrogen levels and can fight harmful bodies that lead to oxidation. Dates increase the level of estrogen in the blood plasma and help produce eggs properly because they contain vitamins (A, B) (Saryono and Rahmawati, 2016). A study conducted on female mice indicated that alcoholic date extract increases the number of follicles (ovarian follicles) and improves female fertility (Dillasamola et al., 2018).

As the natural agent for fertility improvement, a preliminary work stated that palm pollen could enhance fertility factors, whereas astragalus Officinale showed adverse effects on the gonads and sperm in rats (Mehraban et al., 2014). For Labor and Pregnancy enhancement, the consumption of the dates before labor successfully lowered the need for induction, increased labor, increased dilation of the cervix, formed a greater degree of normal labor, and decreased the deceptive dormant stage in the labor 1st stage by about 38% compared to control (Saryono and Rahmawati, 2016). And there is nothing greater than what the Most Merciful said to Mary, peace be upon her, at the birth of the Prophet Jesus, peace be upon him, (And shake the trunk of the palm tree to you, and the freshness of the fruit will fall on you * So eat and drink and cool your eyes) Surat Maryam verse 25-26. As for nursing mothers, dates contain iron, calcium, many vitamins, and mineral salts that improve the quality of breast milk produced, and the glucose in dates increases milk production (Saryono and Rahmawati 2016). As for (male) pollen, it affects the reproductive system of

males and females. Pollen has been used in ancient folk medicine to treat infertility cases and improve fertility due to its richness in estrogen (plant estrogen). Despite the large number of scientific studies conducted on experimental animals, A few studies have been conducted on humans. However, these studies have proven that male pollen is rich in amino acids, fatty acids, flavonoids, and sterols (plant estrogen). These compounds protect male sperm from oxidation, increase their number and improve their quality. Pollen also increases female fertility and egg production (Wahyudi et al., 2015; Tahvilzadeh et al., 2016). As the natural agent for fertility improvement, a preliminary work stated that palm pollen could enhance fertility factors, whereas astragalus Officinale showed adverse effects on the gonads and sperm in rats (Mehraban et al., 2014).

Additional nutraceutical properties and health benefits

Date fruits are recognized as an antihypertensive component for periods (Maqsood et al., 2020). For neurological effects, the extracts of date had a protective effect in mice that have been used as a model of ischemic injury (Majid et al., 2008). Furthermore, animals' consumption of date fruit (250 mg) successfully reduced the neuronal decease of CAl hippocampal neurons caused by focal cerebral ischemia (Majid et al., 2008). In addition, it was stated that feeding mice methanolic extracts of date extract for fifteen days before reperfusion for cerebral ischemia successfully attenuated the brain's endogenous antioxidant defense, thus preventing acute neuronal loss, neuronal shrinkage, and atrophy (Pujari et al., 2011).

The fruits of Date likewise were shown to possess numerous health benefits, including reduced skin wrinkling and Anti-aging in women (Bauza et al., 2002). Beneficial health effects on pregnant and lactating mothers and dry cough, lethargy, headaches are relieving, slight illness in addition to the loss of appetite, eye problems treatment in Morocco, reducing symptoms of diseases, and Neuroprotective and hemolytic potentials (Zaid and Wet 2002; El Arem et al., 2014; Takaeidi et al., 2014).

CONCLUSION

Date palm fruit may be considered a promising natural source of nutraceutical components with perspective nutritional, bioactive, and therapeutic properties. It can be utilized as a low-cost source of natural food to benefit against diseases outbreak and malnutrition status in the affected communities. In industrial aspects, it can function as a natural additive for improving health-promoting foodstuffs for the emerging functional food products, pharmaceutical use, and other purposes in different fields.

Availability of data and materials

The data used to support the findings of this study are included in the article

Declaration of competing interest

The authors declare that they have no conflict of interest

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